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INJURY TO PEACH FRUITS BY GIPSY-MOTH LARVAE

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INTRODUCTION

Injury to the fruit of apple and pear by the gipsy moth (*Porthetria dispar* L.) has been known for a number of years, and methods for limiting it are also well known. Since it had been observed that the foliage of peach was not favored by this insect, control measures seemed unnecessary and were consequently given very little attention until the subject was taken up by the writer after the first reports of injury.

FIRST RECORDS OF INJURY

In the spring of 1927 Glenn W. Herrick, of Cornell University, received a communication from Nelson E. Leonard, of Raynham Center, Mass., stating that his peach orchard was covered with gipsy-moth caterpillars, which were doing considerable damage to the fruit, attacking mainly the calyx cup and the stem, but not feeding on the foliage. He also reported that in 1926 they caused damage amounting to $400 and that in 1927 the loss would be much greater.

This letter, which was referred to the gipsy-moth laboratory at Melrose Highland, Mass., was the first complaint to be received there of injury to peach fruit; accordingly, C. W. Collins visited the orchard to make observations on the nature of the damage. On June 2, 1927, this orchard was again visited by Mr. Collins and the writer and examined thoroughly. All the gipsy-moth larvae found were in the first and second instars and were feeding on the stems of the young peaches which, at that time, were about one-third to one-half inch in diameter. Although the larvae were abundant

[1] The writer acknowledges the helpful suggestions of C. W. Collins, in charge of gipsy and brown-tail moth investigations in the Division of Forest Insects, who made some early observations on the damage to peach, and the assistance of C. M. Symonds in conducting the experiments.

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throughout the orchard, practically no feeding was noted on the foliage.

The stems of the small fruits, being rather thick, soft, and tender (fig. 1), were readily attacked by the larvae, and many of them were almost entirely girdled. (Fig. 2.) On one short branch, 31 of the 43 peaches counted had the stems one-half, or more, girdled; and 21 larvae were found on the branch. On another branch 17 larvae were found, and the stems of 25 of the 44 peaches were partly consumed. The infestation in this orchard was not due to hatching from egg clusters in the orchard but entirely to wind dispersion of the small larvae from heavily infested woodlands, which almost entirely surrounded it. It was estimated that at least half the crop had been ruined; nevertheless, to stop further injury, the owner was advised to make an application of lead arsenate in combination with hydrated lime and nicotine sulphate. This was done that same day.

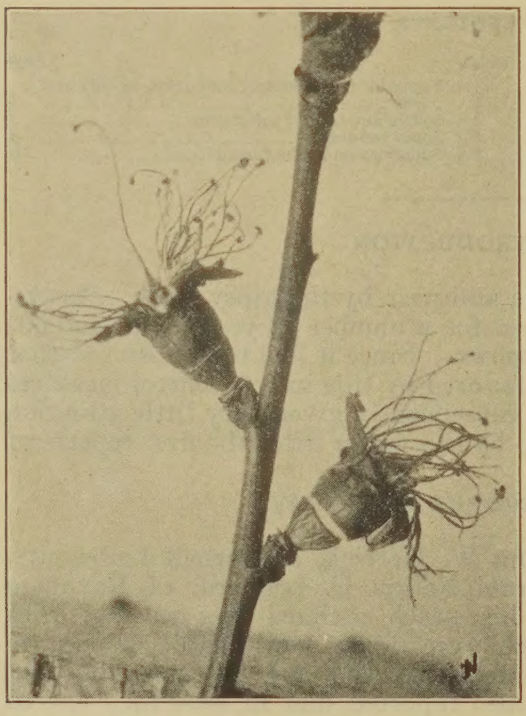

FIGURE 1.—Appearance of peach stems shortly after petals and bud scales have fallen. Gipsy-moth larvae attack these stems readily

On June 17 an examination of the orchard showed that third and fourth instar larvae were feeding on the flesh of the fruit, making large holes near the stems and in other parts of the fruit. (Fig. 3.) The spray applied in the orchard on June 2 had, therefore, been only partially effective in controlling the gipsy moth, as a considerable number of larvae were present on the trees at this time, and only a slight amount of the poison remained.

Further examination on July 7 brought out that most of the peaches which showed stem injury early in the season had fallen off; some, however, remained on the trees as "mummies." Of the 43 peaches on one of the branches on June 2 only 6 remained, and 2 of these were badly scarred. On the branch on which there were 44 peaches on June 2, 11 peaches remained, and 2 of these had been injured. From 8 to 15 larvae in the fourth and fifth instars were noted on a number of the trees. Much of the fruit which was badly gouged on June 17 (fig. 4) still showed the effects of the injury, the injured portions having turned brown or black. The peaches had also become shriveled owing to stem injury, which had cut off the flow of sap. (Fig. 5.)

On July 20 other observations in the orchard showed that only 1 peach remained on the branch which had 43 peaches on it on June 2, and that only 7 peaches remained on the opposite branch which bore

44 peaches on June 2. In going through the orchard it was noted that none of the trees bore a heavy crop, and many peaches of medium to large size, heavily scarred and gouged by the larvae, were found on the ground.

In September, 1927, it was estimated by the owner that 75 per cent of his crop had been destroyed by the gipsy moth. In some parts of his orchard, especially in the portions containing the late varieties, the injury was not so great.

In 1928 a peach orchard in Boxford, Mass., was quite heavily infested with the gipsy moth. This orchard was in a section where defoliation in the woodland areas during this season was very heavy, although the orchard was more remote from the infested woodlands than was the one at Raynham Center. The same year a peach orchard at Carlisle, Mass., showed considerable injury.

In 1929 the writer was consulted in regard to still another peach orchard in Carlisle, Mass., the owner stating that he was getting considerable injured and fallen fruit from his trees. Upon examination, a number of gipsy-moth larvae were found upon them, and many of the peaches showed stem and flesh injury. Although the trees had set heavily with fruit, much of it had fallen off.

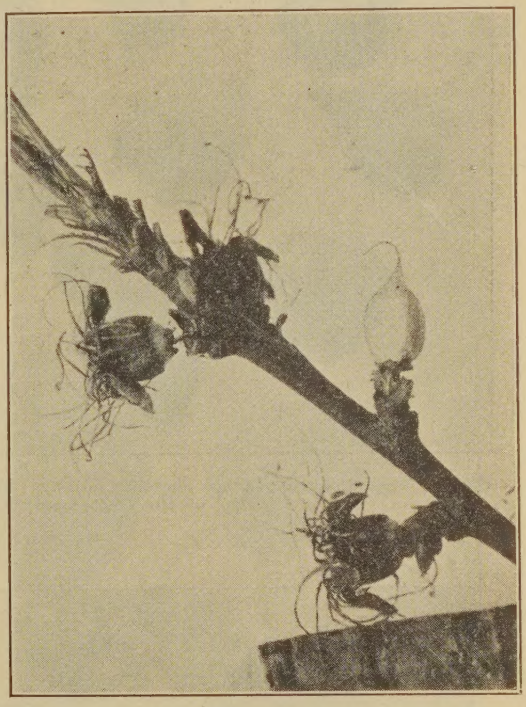

FIGURE 2.—Appearance of peach stems after being fed upon by small gipsy-moth larvae. Note that the stem is almost entirely girdled

EXPERIMENTS IN CONTROL CONDUCTED IN 1928 AT RAYNHAM CENTER, MASS.

In 1928 some experiments were started to find, if possible, a satisfactory method to prevent gipsy-moth injury to peaches. The infestation in 1928 in the woodlands surrounding the peach orchard at Raynham Center was very light, this condition being due to an early defoliation in 1927 which was practically complete. To the resultant starvation were added the effects of parasitism and disease. The orchard was visited on June 1, 1928, but no larvae were found. On this date the peaches were from about one-fourth to one-third of an inch in length, and many of the calyx cups were still clinging to them.

Two peach trees on which there was a good setting of fruit were sprayed on this date, one with powdered lead arsenate in the proportion of 2 pounds to 100 gallons of water and the other with 3 pounds of the same material and 6 pounds of hydrated lime to 100 gallons

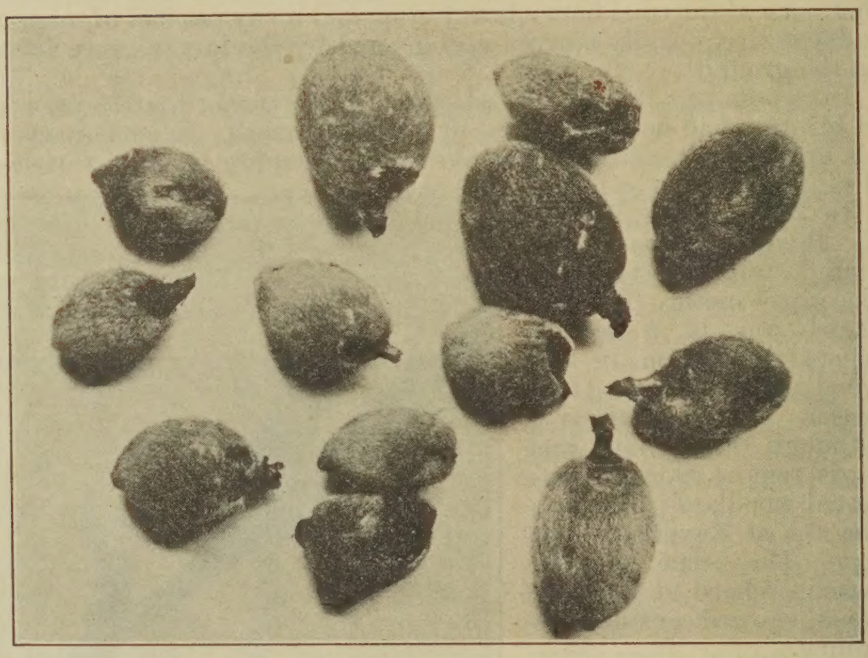

FIGURE 3.—Damaged peaches showing holes made by gipsy-moth larvae in the flesh of the fruit near the stem

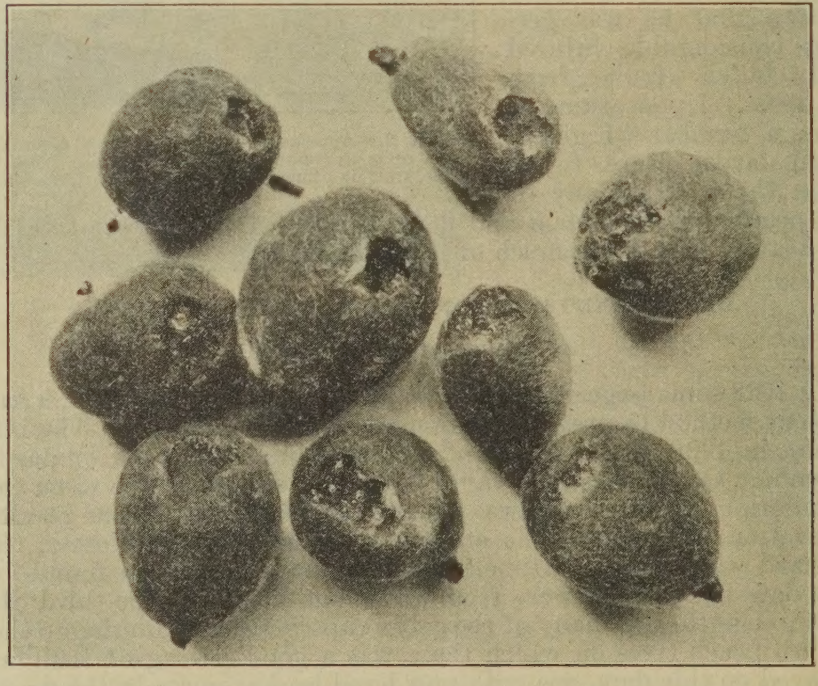

FIGURE 4.—Appearance of peaches after being fed upon by gipsy-moth larvae

of water. Fish oil was added as an adhesive to both mixtures. On each of these sprayed trees a small branch well laden with fruit was selected and inclosed in a cheesecloth sleeve. A similar branch on a third tree, not sprayed, was also inclosed in a similar covering. Within each of these three sleeves were placed 100 first-instar gipsy-moth larvae, after which the open end of the sleeve was closed by being tied around the basal end of the branch.

On June 14 and 26 and July 10 the sprayed branches inclosed in sleeves were examined, and no living larvae were found on them, and practically no damage to the fruit was noted. An examination of

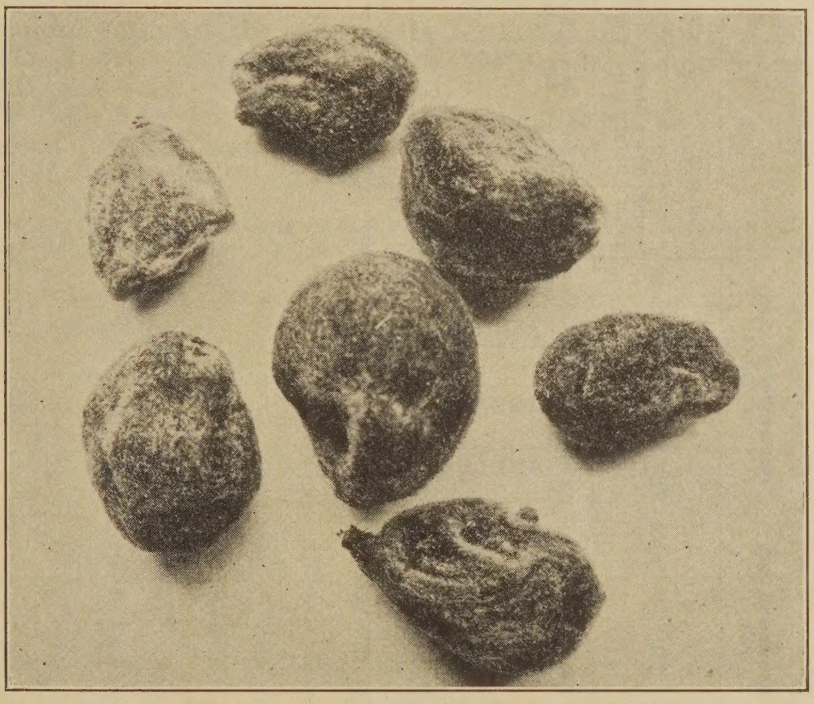

FIGURE 5.—Peaches shriveled and wrinkled by loss of moisture due to stem and flesh injury

the unsprayed branch on the same dates showed much injury, and at the last examination, on July 10, injury to every peach in the sleeve was noted.

AT BOXFORD, MASS.

The orchard at Boxford, though small, was in a district heavily infested with the gipsy moth, and when first observed, in June, 1928, it was estimated that about 50 per cent of the fruit had been injured and about 60 per cent of this destroyed by this insect. The fruit on June 15 averaged three-eighths of an inch in diameter, and from 30 to 80 second and third instar larvae were found on each tree. Although this was too late to obtain the best results, since much injury to the fruit had already been done, a few trees were sprayed to note the amount of control which could be obtained at this time when most of the larvae were feeding at the base of the stem or on the flesh of the fruit.

The trees selected were sprayed on June 15 and 21 with the mixtures shown in Table 1.

TABLE 1.—*Early examinations of results of spraying with powdered lead arsenate for the control of gipsy-moth larvae on peach trees at Boxford, Mass., 1928*

Tree No.	Spray materials in 100 gallons of water			Date of application	Peaches removed from mats				Peaches showing gipsy-moth injury				Larvae found dead on mats							
													June 18		June 21		June 27			Total
	Lead arsenate, pounds	Fish oil, pints	Lime, pound		June 18	June 21	June 27	Total	June 18	June 21	June 27	Total	Second instar	Third instar	Second instar	Third instar	Second instar	Third instar	Fourth instar	
					Number	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*	*Number*
1	4	1	½	June 15	22	74	66	162	20	58	58	136	6	26	2	5	0	1	0	40
4	5	1		do	15	40	41	96	15	31	33	79	8	22	3	10	1	5	2	51
5	4	¾		do	28	112	92	232	28	95	79	202	67	81	16	31	6	19	0	220
7	3	½		do	8	14	13	35	8	14	10	32	10	10	9	11	0	1	0	41
9	(1)				204	224	244	672	175	175	200	550	3	0	4	3	0	1	0	11
10	(1)					382	451	833		245	350	595			0	3	0	0	0	3
13	3	½		June 21			11	11			10	10					21	21	0	42
Total					277	846	918	2,041	246	618	740	1,604	94	139	34	63	28	48	2	408

[1] Check.

These trees were all tagged and numbered, and cloth mats were placed under them. On June 16 the estimated count of living larvae on trees numbered 1, 4, 5, 7, 9, and 10 gave an average of 50 second and third instar larvae on each tree.

On June 18, 21, and 27 collections of dead larvae and fallen peaches were taken from the mats, the results being shown in Table 1.

Table 1 shows that of the total number of peaches removed from the mats on June 18, 89 per cent were injured by gipsy-moth larvae; on June 21, 73 per cent showed injury by this insect; and on June 27, 81 per cent of the fallen peaches showed like injury. Of the dead larvae removed from the mats on the three dates, 96.6 per cent were taken from beneath the sprayed trees, whereas only 3.4 per cent of the dead larvae were taken from the mats under the unsprayed or check trees.

In Table 2 are shown the results of examinations under the same trees on July 2, 5, and 9; and in Table 3 is given a summary of the total of the two preceding tables.

TABLE 2.—*Final examinations of results of spraying with powdered lead arsenate for the control of gipsy-moth larvae on peach trees at Boxford, Mass., 1928*

Tree No.	Peaches removed from mats				Peaches showing gipsy moth injury				Larvae found dead on mats											Total
									July 2			July 5				July 9				
	July 2	July 5	July 9	Total	July 2	July 5	July 9	Total	Second instar	Third instar	Fourth instar	Second instar	Third instar	Fourth instar	Fifth instar	Third instar	Fourth instar	Fifth instar		
	No.	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*	*No.*		*No.*
1	80	10	13	103	45	2	6	53	0	0	0	1	1	0	0	1	0	0		3
4	114	56	36	206	30	10	10	50	0	2	3	0	(1)	(1)	(1)	(1)	(1)	(1)		20
5	98	90	63	251	45	40	20	105	0	0	3	0	(1)	(1)	0	(1)	0	(1)		9
7	23	14	12	49	12	8	6	26	0	1	0	0	0	0	1	0	1	1		4
9 [2]	380	211	138	729	225	40	50	315	2	1	0	?	?	?	?	?	?	?		5
10 [2]	690	272	410	1,372	340	25	150	515	0	0	0	0	0	0	0	?	?	?		3
13	30	15	24	69	25	10	15	50	0	4	3	0	(1)	(1)	0	(1)	(1)	(1)		16
Total	1,415	668	696	2,779	722	135	257	1,114	----	----	----	----	----	----	----	----	----	----		60

[1] Number in each instar not determined, but these instars certainly represented.
[2] Check trees.

TABLE 3.—*Summary of results of spraying with powdered lead arsenate for the control of gipsy-moth larvae on peach trees at Boxford, Mass., 1928.*

Tree No.	Spray materials in 100 gallons of water			Date of application	Peaches removed from mats	Peaches showing gipsy-moth injury	Larvae found dead on mats
	Lead arsenate	Fish oil	Lime				
	Pounds	*Pints*	*Pound*		*Number*	*Number*	*Number*
1	4	1	½	June 15	265	189	43
4	5	1	----------	---do----	302	129	71
5	4	¾	----------	---do----	483	307	229
7	3	½	----------	---do----	84	58	45
9	(1)	----------	----------	----------	1,401	865	16
10	(1)	----------	----------	----------	2,205	1,110	6
13	3	½	----------	June 21	80	60	58
Total	----------	----------	----------	----------	4,820	2,718	468

[1] Check.

From Table 2 it will be seen that the percentage of injured fruit was less than on the three previous dates, it being 51 per cent on July 2, 20.2 per cent on July 5, and 36.9 per cent on July 9. Of the dead larvae removed from the mats on the above three dates, 86.7 per cent were from the sprayed trees and 13.3 per cent from the check trees.

Similarly the summary table (Table 3) shows that 72.7 per cent of the injured fruit was taken from beneath the check trees, and that 95.3 per cent of the dead larvae found were beneath the sprayed trees and but 4.7 per cent beneath the check trees. Stem injury was found on 56.3 per cent of the fallen fruit.

The percentage of injured fruit from the check trees would have been greater had the spray been applied two or three weeks earlier, since much of the stem injury to the fruit had occurred previous to the first treatment, on June 15.

In the experiments conducted at Raynham Center and Boxford the strength of the spray mixtures varied considerably, the lead arsenate content ranging from 2 to 5 pounds per 100 gallons of water. This mixture was combined with hydrated lime and fish oil, or fish oil was added as an adhesive.

Although a few larvae were noted on the sprayed trees for some time following the application, good control was noted in most cases, the exception being where a heavy rain fell shortly after treatment. In the small experiments at Raynham Center the control was excellent, and at Boxford, although the spraying was not done as early as it should have been, good results were noted. From 2 to 3 pounds of lead arsenate to 100 gallons of water was sufficient to give good control, but in all cases where hydrated lime was not added a moderate amount of burning resulted.

From the mat records and observations made in the orchard at Boxford during 1928 it was estimated that from 50 to 65 per cent of the fruit on the untreated trees was injured.

EXPERIMENTS IN CONTROL CONDUCTED IN 1929 AND 1930

During 1929 further experiments were conducted in the peach orchard at Boxford. A few trees were sprayed with lead arsenate 3 pounds, hydrated lime 16 pounds, sulphur 16 pounds, and casein one-half pound, to 100 gallons of water. A few more trees were treated with the same mixture to which fish oil was added as an adhesive. During 1930, in the same orchard, a few peach trees were sprayed with a mixture similar to that used in 1929, and several others with the following mixture: Lead arsenate 3 pounds, hydrated lime 3 pounds, water 100 gallons. To both of the above mixtures fish oil was added as an adhesive, in the proportion of 4 ounces, or one-quarter pint, to each pound of lead arsenate and hydrated lime in the tank. At the time of spraying in both seasons the foliage on the peach trees was one-quarter to one-third developed, the blossoms having just fallen and the bud scales being open just enough to allow the spray to reach the stem. A few first-instar larvae were noted on the trees, but a number of small larvae were aded to increase the intensity of the infestation. Mats were placed beneath some of the sprayed trees and the check trees.

Periodical examinations were made during the feeding season of the larvae and the following results noted. During 1929 and 1930 only slight injury was seen on the sprayed trees, only from 3 to 5 per cent of the fallen peaches on the mats showing stem injury, whereas on the check trees from 17 to 60 per cent of the fallen peaches showed injury. Of the total number of dead larvae removed, approximately 83 per cent were taken from the mats beneath the sprayed trees, the remainder being removed from beneath the check trees.

The sulphur, hydrated lime, casein, and lead arsenate mixture and the hydrated lime-lead arsenate mixture, to both of which fish oil was added as an adhesive, gave equally effective control.

The results, both in 1929 and 1930, showed that little or no stem injury was found on the sprayed trees, whereas on the check trees considerable injury was noted. On the whole, the results secured in the experiments conducted in 1929 and 1930 showed that good control was obtained in the peach orchard by spraying shortly after the blossoms had fallen. Where fish oil was used as an adhesive the poison adhered to the fruit for a longer period, thereby giving an extended protection.

SOURCE AND TIME OF INFESTATION

The presence of a gipsy-moth infestation in a peach orchard can only be detected by an examination about the time the blossoms have fallen or shortly after. Gipsy-moth egg clusters are seldom found in peach orchards, and when present they are on the edge of the orchard adjacent to a growth of favorable food, from which the moths migrate to deposit their eggs. The source of an infestation in a peach orchard is usually adjacent woodlands where small first-instar larvae are more or less abundant. These larvae, shortly after hatching, are blown by the wind for quite a long distance, eventually coming to rest on other foliage at various points surrounding the infestation. If a peach orchard is located in an area of this kind, it is almost sure to become infested to a greater or less degree, depending on the abundance of larvae at the source and the amount of favorable weather for wind spread at the time the young larvae are hatching.

Wind spread of the gipsy moth is usually at its height about the time the blossoms of the peach have fallen and the foliage is partly out. In Melrose, Mass., the wind-spread dates for 1927 to 1930, inclusive, were as follows:

1927—May 2 to 30	1929—May 9 to 26
1928—May 17 to June 6	1930—May 9 to 22

SPRAY RESIDUE

The proper time to spray for the prevention of gipsy-moth injury to peaches is when the foliage is only one-fourth to one-third developed and the fruit is very small, one-fourth to one-third inch in length. Weathering and the growth of the fruit will reduce the residue at harvest time to negligible proportions, even though fish oil is used as an adhesive.

Two peach trees, heavily laden with fruit, located in an orchard at Raynham Center, Mass., were sprayed on May 26, 1931, with the following mixture: Lead arsenate 3 pounds, hydrated lime 3 pounds, water 100 gallons, to which 1½ pints of fish oil was added as an adhesive. On August 10, 1931, about 10 days before harvest time, 25 peaches were removed from the trees, and the quantity of arsenical residue on them determined. The total quantity of arsenic found on the 25 peaches was equivalent to 7 micrograms, or 0.000007 gram, As_2O_3.

SUMMARY AND RECOMMENDATIONS

Observations and experiments conducted over a period of four years have shown that considerable gipsy-moth injury can occur in peach orchards. The larvae feed readily on the foliage as well as on the fruits of the apple and pear; on the peach, however, they feed only sparingly on the older foliage, but attack the tender stems of the small fruits and cause them to drop, and later feed and gouge out deep holes in the flesh of the larger fruits, making them unfit for market.

In the experiments conducted in 1928 it was found that better results were obtained on the peach trees at Raynham Center, Mass., which were sprayed on June 1, than on those sprayed at Boxford, Mass., on June 15 and 21, as much of the damage to the fruit is done by the small larvae. This was clearly shown in the Boxford orchard, where about 50 per cent of the fruit had been injured at the time of the first application of spray on June 15. However, though the poison treatment was late, further injury to the fruit, especially to the flesh, by the larger larvae was considerably retarded or stopped.

All of the experiments conducted and observations made show that in order to prevent serious loss to the peach crop through the gipsy moth it is necessary to spray early in the season, as injury to the stem of the fruit at that time causes it to fall off later.

The experiments conducted in 1929 and 1930 showed that good control can be obtained by spraying. Little or no stem injury was noted on the sprayed trees, although the check trees showed considerable injury.

The source of an infestation in a peach orchard is usually near-by woodlands where small first-instar gipsy-moth larvae are more or less abundant. These larvae are blown to a considerable distance by the wind. The peach orchards become infested during this dispersion period, which is at its height about the time the blossoms of the peach have fallen and while the fruit is very small.

Spraying for the control of the gipsy moth should be done during the dispersion period of the larvae. The experiments have shown that spraying with the following mixture gave good control: Lead arsenate 2 or 3 pounds, hydrated lime 2 or 3 pounds, water 100 gallons. The addition of 1 or 1½ pints of fish oil to the mixture, however, caused it to adhere to the fruit and foliage for a much longer period. More hydrated lime can be added, if it seems necessary, to prevent injury to the foliage by the lead arsenate. In this case more fish oil should be added, since the quantity necessary is determined by allowing 4 ounces, or one-fourth pint, of the oil to each pound of lead arsenate and hydrated lime in the spray tank. The quantity of

water in the spray tank has no bearing on the quantity of fish oil to be used. Other materials, such as sulphur or casein, can also be added at this time. Care should be taken to cover the stem of the fruit with the poison, as the small gipsy-moth larvae begin their feeding at this point.

Even though fish oil is used as an adhesive, the weathering and growth of the fruit will reduce the spray residue by harvest time to negligible proportions.

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